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Hyperloop Freight is a Joke

As the ongoing attempt to build a Hyperloop tube in California is crashing (http://nymag.com/selectall/2016/10/the-kink-in-elon-musks-hyperloop.html) due to entirely foreseen (https://pedestrianobservations.wordpress.com/2013/08/13/loopy-ideas-are-fine-if-youre-an-entrepreneur/) technical problems, the company trying to raise capital for the project, Hyperloop One, is looking at other possibilities in order to save face. A few come from other passenger routes: Stockholm-Helsinki is one option (http://www.theverge.com/2016/7/5/12099612/hyperloop-one-helsinki-stockholm-30-minutes-study), and another is the Dubai-Abu Dhabi (http://www.arabianbusiness.com/abu-dhabi-dubai-hyperloop-route-said-cost-4-8bn-650603.html), which looks like it may happen thanks to the regime's indifference to financial prudence. Those plans aren't any better or worse than the original idea to build it in California. But as part of their refusal to admit failure, the planners are trying to branch into express freight service. Hyperloop freight is especially egregious, in a way that's interesting not only as a way of pointing out that tech entrepreneurs don't always know what they're doing, but also because of its implications for freight service on conventional high-speed rail.

First, let's go back to my most quoted line on Hyperloop. In 2013 I called it a barf ride, because the plan would subject passengers to high acceleration forces, about 5 m/s^2 (conventional rail tops at 1.5 m/s^2, and a plane takes off at 3-4 m/s^2). This is actually worse for freight than for passengers, which is why the speed limits on curves are lower for freight trains than for passenger trains: as always, see Martin Lindahl's thesis (http://www.europakorridoren.se/spargeometri.pdf) for relevant European standards. Freight does not barf, but it does shift, potentially dangerously; air freight is packed tightly in small pellets (https://en.wikipedia.org/wiki/Unit_load_device). Existing freight trains are also almost invariably heavier than passenger trains, and the heavier axle loads make high cant deficiency more difficult, as the added weight pounds the outer rail.

Another potential problem is cant. Normally, canting the tracks provides free sideways acceleration: provided the cant can be maintained, no component of the train or tracks feels the extra force. Cant deficiency, in contrast, is always felt by the tracks and the frame of the train; tilting reduces the force felt in the interior of the train, but not on the frame or in the track. At Hyperloop's proposed speed and curve radius, getting to 5 m/s^2 force felt in the interior of the train, toward the floor, requires extensive canting. Unfortunately, this means the weight vector would point sideways rather than down, which the lightweight elevated tube structure would transmit to concrete pylons, which have high compressible strength but low tensile strength. This restricts any such system to carrying only very lightweight cargo, of mass comparable to that of passengers. This is less relevant to conventional high-speed rail and even maglev, which use more massive elevated structures, but conversely the problem of high forces on the outer rail ensures cant deficiency must be kept low.

Taken together, this means that high-speed freight can't be of the same type as regular freight. Hyperloop One, to its credit, understands this. The managers are furiously trying to find freight – any kind of freight – that can economically fit. This has to involve materials with a high ratio of value to mass, for example perishable food, jewelry, and mail. SNCF ran dedicated TGV mail trains (https://fr.wikipedia.org/wiki/TGV_postal) for 31 years, but decided to discontinue the service last year, in the context of declining mail volumes.

High-speed freight has a last mile problem. Whereas high-speed passenger service benefits from concentration of intercity destinations (https://pedestrianobservations.wordpress.com/2012/05/24/destination-centralization/) near the center of the city or a handful of tourist attractions, high-speed freight service has to reach the entire region to be viable. Freight trains today are designed with trucks for last-mile distribution; starting in the 1910s, industry dispersed away from waterfronts and railyards (https://www.dartmouth.edu/~wfischel/Papers/02-03.pdf). The combination of trucks and electrification led to a form of factory building that is land-intensive and usually not found in expensive areas. Retail is more centralized than industry, but urban supermarkets remain local, and suburban ones are either local or auto-oriented hypermarkets. Even urban shopping malls as in Singapore are designed around truck delivery. The result is that high-speed freight must always contend with substantial egress time.

Let us now look at access time. How are goods supposed to get from where they're made to the train station? With passengers, there are cars and connecting transit at the home end. There's typically less centralization than at the destination end, but in a small origin city like the secondary French and Japanese cities, travel time is not excessive. In a larger city like Osaka it takes longer to get to the train station, but car ownership is lower because of better public transit, which increases intercity rail's mode share. On freight, the situation is far worse: industry is quite dispersed and unlikely to be anywhere near the tracks, while the train station is typically in a congested location. Conventional rail can build a dedicated freight terminal in a farther out location (for example, auto trains in Paris do not use Gare de Lyon but Bercy); an enclosed system like Hyperloop can't.

And if industry is difficult to centralize, think of farmed goods. Agriculture is the least centralized of all economic activities; this is on top of the fact that of all kinds of retail, supermarkets are the most local. Extensive truck operations would be needed, just as they are today. And yet, outside analysts (http://www.forbes.com/sites/alexkonrad/2016/10/25/hyperloop-one-seeks-new-cash-amid-high-costs/) are considering perishables as an example of a good where Hyperloop could compete.

With that in mind, any speed benefits coming from high-speed freight services vanish. There are diminishing returns to speed. Since the cost of extra speed does not diminish, there's always a point where reducing travel time stops being useful, since the effect on door-to-door travel time is too small to justify the extra expense. The higher the total access plus egress time is, the sooner this point is reached, and in freight, the total access and plus egress time is just too long.

In passenger service, the problem of Hyperloop is that it tries to go just a little bit too far beyond conventional high-speed rail. The technical problems are resolvable, at extra cost, and in a few decades, vactrains (probably based on maglev propulsion rather than Elon Musk's air bearings) may become viable for

long-distance passenger rail.

In freight, the situation is very different. Successful freight rail companies, for example the Class I railroads in North America, China Railways, and Russian Railways, make money off of hauling freight over very long distances at low cost. Quite often this is because the freight in question is so heavy that even without substantial fuel taxes, trucks cannot compete on fuel or on labor costs; this is why Western Europe's highest freight rail mode share (http://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics_-_modal_split) is found in Sweden, with its heavy iron ore trains, and in Switzerland, Finland, Austria, with their long-distance freight across the Alps or toward Russia. Increasing speed is not what the industry wants or needs: past US experiments (https://en.wikipedia.org/wiki/Super_C_%28freight_train%29) with fast freight did not succeed financially. The fastest, highest-cost mode of freight today, the airplane, has very low mode share, in contrast with the popularity of planes and high-speed trains in passenger service.

None of this requires deep analysis; in response to Hyperloop One's interest in freight, an expert in logistics asked "why do we need to move cargo at 500 mph? (https://www.inverse.com/article/15590-expert-says-hyperloop-is-wrong-for-shipping-why-do-we-need-to-move-cargo-at-500-mph)". The problem is one of face. The entrepreneurs in charge of Hyperloop One cannot admit that they made a mistake, to themselves, to their investors, or to the public. They are bringing the future to the unwashed masses, or so they think, and this requires them to ignore any problem until after it's been solved, and certainly not to admit failure. Failure is for ordinary people, not for would-be masters of the universe. The announcement of the grand project is always more bombastic and always reaches more people than the news of its demise. It's on those of us who support good transit and good rail service to make sure the next half-baked idea gets all the skepticism and criticism it deserves.